

## General

### Guideline Title

Fractures (complex): assessment and management.

### Bibliographic Source(s)

National Clinical Guideline Centre. Fractures (complex): assessment and management. London (UK): National Institute for Health and Care Excellence (NICE); 2016 Feb 17. 18 p. (NICE guideline; no. 37).

### Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

## Recommendations

### Major Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

The wording used in the recommendations in this guideline (for example, words such as 'offer' and 'consider') denotes the certainty with which the recommendation is made (the strength of the recommendation) and is defined at the end of the "Major Recommendations" field.

NICE has developed four related clinical guidelines and one service delivery guideline related to the management of people with traumatic injuries including this guideline on complex fractures and the following guidelines:

- [Fractures \(non-complex\): assessment and management](#)
- [Major trauma: assessment and initial management](#)
- [Major trauma: service delivery](#)
- [Spinal injury: assessment and initial management](#)

Recommendations apply to both children (under 16s) and adults (16 or over) unless otherwise specified. Some recommendations on management depend on whether the growth plate of the injured bone has closed (skeletal maturity). The age at which this happens varies. In practice, healthcare professionals use clinical judgement to determine skeletal maturity. When a recommendation depends on skeletal maturity this is clearly indicated.

#### Pre-hospital Settings

For recommendations on managing airways, recognising and managing chest trauma, controlling external haemorrhage and fluid replacement, see

the NGC summary of the NICE guideline [Major trauma: assessment and initial management](#).

#### Initial Pharmacological Management of Pain

For recommendations on pain assessment in people with suspected complex fractures, see the NGC summary of the NICE guideline [Major trauma: assessment and initial management](#).

For recommendations on the initial pharmacological management of pain in people with suspected open fractures, see the NGC summary of the NICE guideline [Major trauma: assessment and initial management](#).

For recommendations on the initial pharmacological management of pain in people with suspected high-energy pelvic fractures, see the NGC summary of the NICE guideline [Major trauma: assessment and initial management](#).

For recommendations on the initial pharmacological management of pain in adults with suspected low-energy pelvic fractures, see the NICE guideline [Hip fracture. The management of hip fracture in adults](#) .

For recommendations on the initial pharmacological management of pain in adults with suspected pilon fractures and children with suspected intra-articular distal tibia fractures, see the NGC summary of the NICE guideline [Fractures \(non-complex\): assessment and management](#).

#### Using a Pelvic Binder

If active bleeding is suspected from a pelvic fracture following blunt high-energy trauma:

- Apply a purpose-made pelvic binder, or
- Consider an improvised pelvic binder but only if a purpose-made binder does not fit

#### Initial Management of Open Fractures before Debridement

Do not irrigate open fractures of the long bones, hindfoot or midfoot in pre-hospital settings.

Consider a saline-soaked dressing covered with an occlusive layer for open fractures in pre-hospital settings.

In the pre-hospital setting, administer prophylactic intravenous antibiotics as soon as possible and preferably within 1 hour of injury to people with open fractures without delaying transport to hospital.

#### Splinting Long Bone Fractures of the Leg in the Pre-hospital Setting

In the pre-hospital setting, consider the following for people with suspected long bone fractures of the legs:

- A traction splint or adjacent leg as a splint if the suspected fracture is above the knee
- A vacuum splint for all other suspected long bone fractures

#### Destination for People with Suspected Fractures

Transport people with suspected open fractures:

- Directly to a major trauma centre<sup>1</sup> or specialist centre that can provide orthoplastic care if a long bone, hindfoot or midfoot are involved, or
- To the nearest trauma unit or emergency department if the suspected fracture is in the hand, wrist or toes, unless there are pre-hospital triage indications for direct transport to a major trauma centre

Transport people with suspected pelvic fractures:

- To the nearest hospital if suspected pelvic fracture is the only pre-hospital triage indication
- Directly to a major trauma centre<sup>1</sup> if they also have other pre-hospital triage indications for major trauma

Note: In some locations or circumstances, intermediate care in a trauma unit might be needed for urgent treatment, in line with agreed practice within the regional trauma network.

#### Hospital Settings

See recommendations above for advice on initial management of pain.

#### Vascular Injury

Use hard signs (lack of palpable pulse, continued blood loss, or expanding haematoma) to diagnose vascular injury.

Do not rely on capillary return or Doppler signal to exclude vascular injury.

Perform immediate surgical exploration if hard signs of vascular injury persist after any necessary restoration of limb alignment and joint reduction.

In people with a devascularised limb following long bone fracture, use a vascular shunt as the first surgical intervention before skeletal stabilisation and definitive vascular reconstruction.

Do not delay revascularisation for angiography in people with complex fractures.

For humeral supracondylar fractures in children (under 16s) without a palpable radial pulse but with a well-perfused hand, consider observation rather than immediate vascular intervention.

### Compartment Syndrome

In people with fractures of the tibia, maintain awareness of compartment syndrome for 48 hours after injury or fixation by:

- Regularly assessing and recording clinical symptoms and signs in hospital
- Considering continuous compartment pressure monitoring in hospital when clinical symptoms and signs cannot be readily identified (for example, because the person is unconscious or has a nerve block)
- Advising people how to self-monitor for symptoms of compartment syndrome, when they leave hospital

### Whole-Body Computed Tomography (CT) of Multiple Injuries

Use whole-body CT (consisting of a vertex-to-toes scanogram followed by CT from vertex to mid-thigh) in adults (16 or over) with blunt major trauma and suspected multiple injuries. Patients should not be repositioned during whole-body CT.

Use clinical findings and the scanogram to direct CT of the limbs in adults (16 or over) with limb trauma.

Do not routinely use whole-body CT to image children (under 16s). Use clinical judgement to limit CT to the body areas where assessment is needed.

### Pelvic Fractures

#### *Secondary Transfer to a Major Trauma Centre or Specialist Centre*

The NGC summary of the NICE guideline [Major trauma: service delivery](#) contains a recommendation for ambulance and hospital trust boards, medical directors and senior managers on transfer between emergency departments.

Immediately transfer people with haemodynamic instability from pelvic or acetabular fractures to a major trauma centre for definitive treatment of active bleeding.

Transfer people with pelvic or acetabular fractures needing specialist pelvic reconstruction to a major trauma centre or specialist centre within 24 hours of injury.

Immediately transfer people with a failed closed reduction of a native hip joint to a specialist centre if there is insufficient expertise for open reduction at the receiving hospital.

#### *Pelvic Imaging*

Use CT for first-line imaging in adults (16 or over) with suspected high-energy pelvic fractures.

For first-line imaging in children (under 16s) with suspected high-energy pelvic fractures:

- Use CT rather than X-ray when CT of the abdomen or pelvis is already indicated for assessing other injuries
- Consider CT rather than X-ray when CT of the abdomen or pelvis is not indicated for assessing other injuries

Use clinical judgement to limit CT to the body areas where assessment is needed.

#### *Controlling Pelvic Haemorrhage*

The NGC summary of the NICE guideline [Major trauma: service delivery](#) contains a recommendation for ambulance and hospital trust boards,

medical directors and senior managers on interventional radiology and definitive open surgery.

For first-line invasive treatment of active arterial pelvic bleeding, use:

- Interventional radiology if emergency laparotomy is not needed for abdominal injuries
- Pelvic packing if emergency laparotomy is needed for abdominal injuries

#### *Removing a Pelvic Binder*

For people with suspected pelvic fractures and pelvic binders, remove the binder as soon as possible if:

- There is no pelvic fracture, or
- A pelvic fracture is identified as mechanically stable, or
- The binder is not controlling the mechanical stability of the fracture, or
- There is no further bleeding or coagulation is normal

Remove all pelvic binders within 24 hours of application.

Before removing the pelvic binder, agree with a pelvic surgeon how a mechanically unstable fracture should be managed.

#### *Log Rolling*

Do not log roll people with suspected pelvic fractures before pelvic imaging unless:

- An occult penetrating injury is suspected in a person with haemodynamic instability
- Log rolling is needed to clear the airway (for example, suction is ineffective in a person who is vomiting)

When log rolling, pay particular attention to haemodynamic stability.

#### *Open Fractures*

##### *Management of Open Fractures before Debridement*

Do not irrigate open fractures of the long bones, hindfoot or midfoot in the emergency department before debridement.

Consider a saline-soaked dressing covered with an occlusive layer (if not already applied) for open fractures in the emergency department before debridement.

In the emergency department, administer prophylactic intravenous antibiotics immediately to people with open fractures if not already given.

##### *Limb Salvage in People with Open Fractures*

Do not base the decision whether to perform limb salvage or amputation on an injury severity tool score.

Perform emergency amputation when:

- A limb is the source of uncontrollable life-threatening bleeding, or
- A limb is salvageable but attempted preservation would pose an unacceptable risk to the person's life, or
- A limb is deemed unsalvageable after orthoplastic assessment

Include the person and their family members or carers (as appropriate) in a full discussion of the options if this is possible.

Base the decision whether to perform limb salvage or delayed primary amputation on multidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist and the person and their family members or carers (as appropriate).

When indicated, perform the delayed primary amputation within 72 hours of injury.

##### *Debridement, Staging of Fixation and Cover*

Surgery to achieve debridement, fixation and cover of open fractures of the long bone, hindfoot or midfoot should be performed concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).

Perform debridement:

- Immediately for highly contaminated open fractures
- Within 12 hours of injury for high-energy open fractures (likely Gustilo–Anderson classification type IIIA or type IIIB) that are not highly contaminated
- Within 24 hours of injury for all other open fractures

Perform fixation and definitive soft tissue cover:

- At the same time as debridement if the next orthopaedic list allows this within the time to debridement recommended above, or
- Within 72 hours of injury if definitive soft tissue cover cannot be performed at the time of debridement

When internal fixation is used, perform definitive soft tissue cover at the same time.

Consider negative pressure wound therapy after debridement if immediate definitive soft tissue cover has not been performed.

#### Pilon Fractures in Adults (Skeletally Mature)

Create a definitive management plan and perform initial surgery (temporary or definitive) within 24 hours of injury in adults (skeletally mature) with displaced pilon fractures.

If a definitive management plan and initial surgery cannot be performed at the receiving hospital within 24 hours of injury, transfer adults (skeletally mature) with displaced pilon fractures to an orthopaedic centre (ideally this would be emergency department to emergency department transfer to avoid delay).

Immediately transfer adults (skeletally mature) with displaced pilon fractures to an orthopaedic centre if there are wound complications.

#### Intra-articular Distal Tibia Fractures in Children (Skeletally Immature)

Create a definitive management plan involving a children's orthopaedic trauma specialist within 24 hours of diagnosis in children (skeletally immature) with intra-articular distal tibia fractures.

If a definitive management plan and surgery cannot be performed at the receiving hospital, transfer children (skeletally immature) with intra-articular distal tibia fractures to a centre with a children's orthopaedic trauma specialist (ideally this would be emergency department to emergency department transfer to avoid delay).

#### Documentation

The NGC summary of the NICE guideline [Major trauma: service delivery](#) contains recommendations for ambulance and hospital trust boards, senior managers and commissioners on documentation within a trauma network.

Follow a structured process when handing over care within the emergency department (including shift changes) and to other departments. Ensure that the handover is documented.

Ensure that all patient documentation, including images and reports, goes with patients when they are transferred to other departments or centres.

Produce a written summary, which gives the diagnosis, management plan and expected outcome, and:

- Is aimed at and sent to the patient's general practitioner (GP) within 24 hours of admission
- Includes a summary written in plain English that is understandable by patients, family members and carers
- Is readily available in the patient's records

#### Photographic Documentation of Open Fracture Wounds

All trusts receiving patients with open fractures must have information governance policies in place that enable staff to take and use photographs of open fracture wounds for clinical decision-making 24 hours a day. Protocols must also cover the handling and storage of photographic images of open fracture wounds.

Consider photographing open fracture wounds when they are first exposed for clinical care, before debridement and at other key stages of management.

Keep any photographs of open fracture wounds in the patient's records.

#### Documentation of Neurovascular Status

When assessing neurovascular status in a person with a limb injury, document for both limbs:

- Which nerves and nerve function have been assessed and when
- The findings, including:
  - Sensibility
  - Motor function using the Medical Research Council (MRC) grading system
- Which pulses have been assessed and when
- How circulation has been assessed when pulses are not accessible

Document and time each repeated assessment.

#### Information and Support for Patients, Family Members and Carers

The NGC summary of the NICE guideline [Major trauma: service delivery](#) contains a recommendation for ambulance and hospital trust boards, senior managers and commissioners on providing information and support for patients, family members and carers.

#### Providing Support

When communicating with patients, family members and carers:

- Manage expectations and avoid misinformation
- Answer questions and provide information honestly, within the limits of your knowledge
- Do not speculate and avoid being overly optimistic or pessimistic when discussing information on further investigations, diagnosis or prognosis
- Ask if there are any other questions

The trauma team structure should include a clear point of contact for providing information to patients, their family members and carers.

If possible, ask the patient if they want someone (family member, carer or friend) with them.

Reassure people while they are having procedures for fractures under local and regional anaesthesia.

#### *Support for Children and Vulnerable Adults*

Allocate a dedicated member of staff to contact the next of kin and provide support for unaccompanied children and vulnerable adults.

Contact the mental health team as soon as possible for patients who have a preexisting psychological or psychiatric condition that might have contributed to their injury, or a mental health problem that might affect their wellbeing or care in hospital.

For a child or vulnerable adult with a complex fracture, enable their family members or carers to remain within eyesight if appropriate.

Work with family members and carers of children and vulnerable adults to provide information and support. Take into account the age, developmental stage and cognitive function of the child or vulnerable adult.

Include siblings of an injured child when offering support to family members and carers.

#### Providing Information

Explain to patients, family members and carers, what is happening and why it is happening. Provide:

- Information on known injuries
- Details of immediate investigations and treatment, and if possible include time schedules

Offer people with fractures the opportunity to see images of their injury, taken before and after treatment.

Provide people with fractures with both verbal and written information on the following when the management plan is agreed or changed:

- Expected outcomes of treatment, including time to returning to usual activities and the likelihood of permanent effects on quality of life (such as pain, loss of function and psychological effects)
- Amputation, if this is a possibility
- Activities they can do to help themselves
- Home care options, if needed

- Rehabilitation, including whom to contact and how (this should include information on the importance of active patient participation for achieving goals and the expectations of rehabilitation)
- Mobilisation and weight-bearing, including upper limb load bearing for arm fractures

Document all key communications with patients, family members and carers about the management plan.

Ensure that all health and social care practitioners have access to information previously given to people with fractures to enable consistent information to be provided.

#### *Providing Information about Transfer from an Emergency Department*

For patients who are being transferred from an emergency department to another centre, provide verbal and written information that includes:

- The reason for the transfer
- The location of the receiving centre and the patient's destination within the receiving centre
- The name and contact details of the person responsible for the patient's care at the receiving centre
- The name and contact details of the person who was responsible for the patient's care at the initial hospital

#### Training and Skills

These recommendations are for ambulance and hospital trust boards, medical directors and senior managers within trauma networks.

Ensure that each healthcare professional within the trauma service has the training and skills to deliver, safely and effectively, the interventions they are required to give, in line with the NGC summaries of the NICE guidelines [Fractures \(non-complex\): assessment and management](#), this guideline on complex fractures, [Major trauma: assessment and initial management](#), [Major trauma: service delivery](#), and [Spinal injury: assessment and initial management](#).

Enable each healthcare professional who delivers care to people with fractures to have up-to-date training in the interventions they are required to give.

#### Definitions

##### Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Committee makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Committee is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

##### *Interventions That Must (or Must Not) Be Used*

The Guideline Committee usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the Guideline Committee uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

##### *Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation*

The Guideline Committee uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The Guideline Committee uses similar forms of words (for example, 'Do not offer...') when confident that an intervention will not be of benefit for most patients.

##### *Interventions That Could Be Used*

The Guideline Committee uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

## Clinical Algorithm(s)

A National Institute for Health and Care Excellence (NICE) pathway titled "Trauma overview" is provided on the [NICE Web site](#)

## Scope

### Disease/Condition(s)

- Complex fractures
- Open fractures
- Pilon fractures
- Pelvic fractures, including acetabular fractures

### Guideline Category

Diagnosis

Evaluation

Management

Treatment

### Clinical Specialty

Emergency Medicine

Internal Medicine

Orthopedic Surgery

Pediatrics

Radiology

### Intended Users

Advanced Practice Nurses

Emergency Medical Technicians/Paramedics

Health Care Providers

Hospitals

Nurses

Patients

Physician Assistants

Physicians

### Guideline Objective(s)

To develop a guideline using three injuries as examples (open fracture, pelvic fracture and pilon fracture) to inform various stages on the pathway



of patient care that would be of benefit to patients, clinicians and healthcare providers in the treatment of complex fractures

## Target Population

Adults, young people and children who present with a suspected complex fracture:

- People with open fractures
- People with pilon fractures
- People with pelvic fractures, including those with acetabular fractures

Note: The following groups are not covered by this guideline: any person with a non-complex fracture, skull fracture, hip fracture, or spinal injury.

## Interventions and Practices Considered

1. Management in pre-hospital settings
  - Initial pharmacological management of pain
  - Using a pelvic binder
  - Initial management of open fractures before debridement (irrigation [not recommended], saline-soaked dressing covered with an occlusive layer, prophylactic intravenous antibiotics)
  - Splinting long bone fractures of the leg in the pre-hospital setting (traction splint or use of the adjacent leg as a splint, vacuum splint)
  - Transport to appropriate destination (direct transport to major trauma centre or specialist centre, transport to nearest trauma unit or emergency department, transport to hospital)
2. Management in hospital settings
  - Initial management of pain
  - Management of vascular injury
  - Management of compartment syndrome
  - Whole-body computed tomography (CT) of multiple injuries
  - Management of pelvic fractures (secondary transfer to a major trauma centre or specialist centres, CT imaging, controlling pelvic haemorrhage, removing a pelvic binder, log rolling)
  - Management of open fractures (irrigation [not recommended], saline-soaked dressing covered with an occlusive layer, prophylactic intravenous antibiotics, limb salvage, amputation, debridement, staging of fixation and cover)
  - Management of pilon fractures in adults (definitive management plan, performing initial surgery, immediate transfer to orthopaedic centre when appropriate)
  - Management of intra-articular distal tibia fractures in children (definitive management plan, performing initial surgery, transfer to a centre with a children's orthopaedic trauma specialist when appropriate)
3. Documentation
  - Ensuring that all patient documentation, including images and reports, goes with patients when they are transported
  - Producing a written summary
  - Photographic documentation of open fracture wounds
  - Documentation of neurovascular status
4. Information and support
  - Providing support for patients, family members and carers
  - Providing support for children and vulnerable adults
  - Providing information about transfer from an emergency department
5. Training and skills
  - Ensuring that healthcare professional within the trauma service have the training and skills to deliver interventions safely and effectively
  - Enabling healthcare professionals caring for fractures to have up-to-date training in all required interventions

## Major Outcomes Considered

- Adverse effects associated with assessment and management
- Functional scales that quantify level of disability
- Health-related quality of life

- Return to normal activities
- Healthcare contacts: duration and continuity
- Morbidity
- Mortality
- Patient-reported outcomes
- Place of residence at 90 days
- Length of hospital stay
- Cost-effectiveness

## Methodology

### Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

### Description of Methods Used to Collect/Select the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

#### Developing the Review Questions and Outcomes

Review questions were developed in a PICO framework (patient, intervention, comparison and outcome) for intervention reviews. Review questions were developed with a framework of population, prognostic factor and outcomes for prognostic reviews, and with a framework of population, index tests, reference standard and target condition for reviews of diagnostic test accuracy. This was to guide the literature searching process, critical appraisal and synthesis of evidence, and to facilitate the development of recommendations by the Guideline Development Group (GDG). They were drafted by the NCGC technical team and refined and validated by the GDG. The questions were based on the key clinical areas identified in the scope (see Appendix A).

A total of 33 review questions were identified.

Full literature searches, critical appraisals and evidence reviews were completed for all the specified review questions.

#### Searching for Evidence

##### Clinical Literature Search

The aim of the literature search was to systematically identify all published clinical evidence relevant to the review questions. Searches were undertaken according to the parameters stipulated within the NICE Guidelines Manual (2012) (see the "Availability of Companion Documents" field). Databases were searched using medical subject headings and free-text terms. Foreign language studies were not reviewed and, where possible, searches were restricted to articles published in the English language. All searches were conducted in MEDLINE, EMBASE and the Cochrane Library, and were updated for the final time between 25th March and 16 April 2015. No papers after this date were considered.

Search strategies were quality assured by cross-checking reference lists of highly relevant papers, analysing search strategies in other systematic reviews, and asking GDG members to highlight any additional studies. The questions, the study types applied, the databases searched and the years covered can be found in Appendix F.

The titles and abstracts of records retrieved by the searches were sifted for relevance, with potentially significant publications obtained in full text. These were then assessed against the inclusion criteria.

##### Health Economic Literature Search

Systematic searches were undertaken to identify relevant health economic evidence within the published literature. The National Health Service Economic Evaluation Database (NHS EED), the Health Economic Evaluations Database (HEED) and Health Technology Assessment (HTA) database were searched using broad population terms and no date restrictions. A search was also run in MEDLINE and EMBASE using a specific economic filter with population terms. Where possible, searches were restricted to articles published in the English language. Economics search strategies are included in Appendix F. All searches were updated for the final time on 16th or 17th April 2015. No papers published after this date were considered.

### Evidence Gathering and Analysis

The tasks of the research fellow are listed below and described in further detail in the full version of the guideline. The research fellow:

- Identified potentially relevant studies for each review question from the relevant search results by reviewing titles and abstracts, and deciding which should be ordered as full papers. Full papers were then obtained.
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify studies that addressed the review question in the appropriate population and reported on outcomes of interest (see Appendix C for review protocols).

### Inclusion and Exclusion Criteria

The inclusion and exclusion of studies was based on the criteria defined in the review protocols (see Appendix C). Excluded studies by review question (with the reasons for their exclusion) are listed in Appendix J. The GDG was consulted about any uncertainty regarding inclusion or exclusion.

The key population inclusion criterion was:

- People of all ages experiencing an open, pelvic or pilon fracture as a result of a traumatic physical event.

The key population exclusion criterion was people with:

- Non-complex fractures (this is covered in the NGC summary of the NICE guideline [Fractures \[non-complex\]: assessment and management](#))
- Skull fracture
- Hip fracture
- Spinal injury (this is covered in the NGC summary of the NICE guideline [Spinal injury: assessment and initial management](#))

Conference abstracts were not automatically excluded from any review, but no relevant conference abstracts were identified for this guideline. Literature reviews, posters, letters, editorials, comment articles, unpublished studies and studies not in English were excluded.

### Type of Studies

Randomised trials, non-randomised trials and observational studies (including diagnostic or prognostic studies) were included in the evidence reviews as appropriate.

For most intervention reviews in this guideline, parallel randomised controlled trials (RCTs) were included because they are considered the most robust type of study design that could produce an unbiased estimate of the intervention effects. Crossover RCTs were not appropriate for any questions.

If non-randomised studies were appropriate for inclusion in intervention reviews (that is, non-drug trials with no randomised evidence) the GDG identified a priori in the protocol the variables which must either be equivalent at baseline or that the analysis had to adjust for any baseline differences. If the study did not fulfil either criterion, it was excluded. Please refer to Appendix C for full details on the study design of studies selected for each review question. Where data from observational studies were included, meta-analysis was conducted provided the studies had comparable populations, interventions and comparators. Because observational studies had to consider all key confounding variables, it was assumed that there were no important differences between studies in terms of the extent that confounding had occurred, and meta-analysis was therefore regarded as acceptable in this context.

For diagnostic reviews, diagnostic RCTs, cross-sectional and retrospective studies were included. For prognostic reviews, prospective and retrospective cohort studies were included. Case-control studies were not included.

### Contacting Authors

If a study had inadequate information to permit a full evaluation of risk of bias, or had insufficient details on the outcomes, then the GDG had the option to request more information from the study's authors.

This only occurred once in the guideline. For the timing of debridement review, further data was requested and received from researchers involved in the Davis-Sears, 2012 study.

### Evidence of Cost-effectiveness

Evidence on cost-effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the economic literature
- Undertook new cost-effectiveness analysis in priority areas

### Literature Review

The health economist:

- Identified potentially relevant studies for each review question from the economic search results by reviewing titles and abstracts – full papers were then obtained
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify relevant studies (see below for details)

### *Inclusion/Exclusion*

Full economic evaluations (studies comparing costs and health consequences of alternative courses of action: cost-utility, cost-effectiveness, cost-benefit and cost-consequence analyses) and comparative costing studies that addressed the review question in the relevant population were considered potentially applicable as economic evidence.

Studies that only reported cost per hospital (not per patient) or only reported average cost-effectiveness without disaggregated costs and effects were excluded. Abstracts, posters, reviews, letters/editorials, foreign language publications and unpublished studies were excluded. Studies judged to have an applicability rating of 'not applicable' were excluded (this included studies that took the perspective of a non-Organisation for Economic Co-operation and Development [OECD] country).

Remaining studies were prioritised for inclusion based on their relative applicability to the development of this guideline and the study limitations. For example, if a high quality, directly applicable UK analysis was available, other less relevant studies may not have been included. Where exclusions occurred on this basis, this is noted in the relevant section.

For more details about the assessment of applicability and methodological quality see the economic evaluation checklist (The Guidelines Manual, Appendix H and the health economics research protocol in Appendix C in the full guideline appendices).

When no relevant economic analysis was found from the economic literature review, relevant UK NHS unit costs related to the compared interventions were presented to the GDG to inform the possible economic implication of the recommendation being made.

## Number of Source Documents

See Appendix D: Clinical Article Selection and Appendix E: Economic Article Selection (see the "Availability of Companion Documents" field) for detailed flow charts on the article selection process, including total number of records identified through database searching, records screened, records excluded, full-text articles assessed for eligibility, studies included in review, and studies excluded from review.

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Overall Quality of Outcome Evidence in Grading of Recommendations Assessment, Development and Evaluation (GRADE)

Level	Description
<b>High</b>	Further research is very unlikely to change confidence in the estimate of effect.
<b>Moderate</b>	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.

<b>Low level</b>	Further research is very likely to have an important impact on the estimate of effect and is likely to change the estimate.
<b>Very Low</b>	Any estimate of effect is very uncertain.

## Methods Used to Analyze the Evidence

Meta-Analysis

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

### Evidence Gathering and Analysis

The tasks of the research fellow are listed below and described in further detail in the full version of the guideline. The research fellow:

- Critically appraised relevant studies using the appropriate study design checklists as specified in The Guidelines Manual [2012] (see the "Availability of Companion Documents" field).
- Critically appraised relevant studies with a prognostic or qualitative study design NCGC checklist.
- Extracted key information about interventional study methods and results using Evibase, NCGC purpose-built software. Evibase produces summary evidence tables, with critical appraisal ratings. Key information about non-interventional study methods and results were manually extracted onto standard evidence tables and critically appraised separately (see Appendix G for the evidence tables).
- Generated summaries of the evidence by outcome. Outcome data is combined, analysed and reported according to study design:
  - Randomised data is meta-analysed where appropriate and reported in Grading of Recommendations Assessment, Development and Evaluation (GRADE) profiles.
  - Observational data presented as a range of values in GRADE profiles.
  - Diagnostic data is meta-analysed if appropriate or presented as a range of values in adapted GRADE profiles.
  - Prognostic data is meta-analysed where appropriate and reported in GRADE profiles.
  - Qualitative data is summarised across studies where appropriate and reported in themes.
- A sample of a minimum of 20% of the abstract lists of the siffs of the first three questions by new reviewers were double sifted by a senior research fellow. As no papers were missed by any reviewers, no further double sifting was carried out. All of the evidence reviews were quality assured by a senior research fellow. This included checking:
  - Papers were included or excluded appropriately
  - A sample of the data extractions
  - Correct methods were used to synthesise data
  - A sample of the risk of bias assessments

### Methods of Combining Evidence

#### *Data Synthesis for Intervention Reviews*

Where possible, meta-analyses were conducted to combine the data from the studies for each of the outcomes in the review question using RevMan5 software. All analyses were stratified for skeletal maturity or age (under 18 years and 18 years or over), which meant that different studies with predominant groups (whether skeletal maturity or age) in different age strata were not combined and analysed together. For some questions, additional stratification was used, and this is documented in the individual question protocols (see Appendix C). If additional strata were used this led to sub-strata (for example, 2 stratification criteria would lead to 4 sub-strata categories, or 3 stratification criteria would lead to 8 sub-strata categories) which would be analysed separately.

Age was defined as the stratification group in the protocols. However, it was decided after reviews were started that skeletal maturity was seen as a more clinically relevant strata. Skeletal maturity leads to different recovery trajectories and informs different forms of management. It can occur at

various ages and can vary between bones. However, often papers did not specify the skeletal maturity of the sample. Consequently, analyses were split by skeletal maturity where possible, and by an age proxy where this wasn't reported.

See Section 4.3.4.1 of the full version of the guideline for details regarding analysis of different types of data including dichotomous outcomes, continuous outcomes, generic inverse variance, heterogeneity, and complex analysis/further analysis.

#### *Data Synthesis for Diagnostic Test Accuracy Reviews*

Two separate review protocols were produced to reflect the two different diagnostic study designs:

##### Diagnostic Randomised Controlled Trials (RCTs)

Diagnostic RCTs (sometimes referred to as test and treat trials) are a randomised comparison of two diagnostic tests, with study outcomes being clinically important consequences of diagnostic accuracy (patient outcomes similar to those in intervention trials, such as mortality). Patients are randomised to receive test A or test B, followed by identical therapeutic interventions based on the results of the test (that is, someone with a positive result would receive the same treatment regardless of whether they were diagnosed by test A or test B). Downstream patient outcomes are then compared between the two groups. As treatment is the same in both arms of the trial, any differences in patient outcomes will reflect the accuracy of the tests in correctly establishing who does and does not have the condition. Diagnostic RCTs were searched for first in preference to diagnostic accuracy studies. Data was synthesised using the same methods for intervention reviews (see dichotomous or continuous outcomes in Section 4.3.4.1 of the full version of the guideline).

##### Diagnostic Accuracy Studies

For diagnostic test accuracy studies, a positive result on the index test was found in two different ways, according to whether the index test was measured on a continuous scale or was bivariate. For continuous index test measures, a positive result on the index test was found if the patient had values of the chosen measured quantity above or below a threshold value, and different thresholds could be used. The threshold of a diagnostic test is defined as the value at which the test can best differentiate between those with and without the target condition and, in practice, it varies amongst studies. Diagnostic test accuracy measures used in the analysis were sensitivity and specificity, and, if different diagnostic thresholds were used within a single study, area under the receiver operating characteristics (ROC) curve.

For bivariate index test measures, a positive result on the index test was found if a particular clinical sign was detected. For example, a positive test would be recorded if a fracture was observed. Diagnostic test accuracy measures used in the analysis were sensitivity and specificity.

Coupled forest plots of sensitivity and specificity with their 95% confidence intervals (CIs) across studies (at various thresholds) were produced for each test using RevMan5. In order to do this, 2x2 tables (the number of true positives, false positives, true negatives and false negatives) were directly taken from the study if given, or else were derived from raw data or calculated from the set of test accuracy statistics.

Diagnostic meta-analysis was conducted where appropriate; that is, when 5 or more studies were available per threshold. Test accuracy for the studies was pooled using the bivariate method modelled in Winbugs®. The bivariate method uses logistic regression on the true positives, true negatives, false positives and false negatives reported in the studies. Overall sensitivity and specificity and confidence regions were plotted. For scores with less than five studies, median sensitivity and the paired specificity were reported where possible. If an even number of studies were reported, the lowest value of the two middle pairs was reported.

Heterogeneity or inconsistency amongst studies was visually inspected in the forest plots.

#### *Data Synthesis for Risk Prediction Rules*

Evidence reviews on risk prediction rules/tools results were presented separately for discrimination and calibration. The discrimination data was analysed according to the principles outlined under the section on data synthesis for diagnostic accuracy studies above. Calibration data, for example,  $R^2$ , if reported was presented separately to the discrimination data. The results were presented for each study separately along with the quality rating for the study. Inconsistency and imprecision were not assessed.

#### *Data Synthesis for Qualitative Reviews*

For each included paper sub-themes were identified and linked to a generic theme. An example of a sub-theme identified by patients and carers is 'keeping an open channel of communication about reasons for any delays in the emergency room' and this is linked to a broader generic theme of 'information'. In some cases, subthemes would relate to more than one generic theme. A summary evidence table of generic themes and underpinning sub-themes was then produced alongside the quality of the evidence.

#### *Appraising the Quality of Evidence by Outcomes*

The evidence for outcomes from the included RCT and observational studies were evaluated and presented using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international [GRADE working group](#). The software (GRADEpro) developed by the GRADE working group was used to assess the quality of each outcome, taking into account individual study quality and the meta-analysis results.

Each outcome was first examined for each of the quality elements listed and defined in Table 2 in the full version of the guideline.

Details of how the four main quality elements (risk of bias, indirectness, inconsistency and imprecision) were appraised for each outcome are given in the full version of the guideline. Publication or other bias was only taken into consideration in the quality assessment if it was apparent.

### Overall Grading of the Quality of Clinical Evidence

Once an outcome had been appraised for the main quality elements, an overall quality grade was calculated for that outcome. The scores from each of the main quality elements (0, -1 or -2) were summed to give a score that could be anything from 0 (the best possible) to -8 (the worst possible). However, scores were capped at -3. This final score was then applied to the starting grade that had originally been applied to the outcome by default, based on study design. For example, all RCTs started as High and the overall quality became Moderate, Low or Very low if the overall score was -1, -2 or -3 points, respectively. The significance of these overall ratings is explained in the "Rating Scheme for the Strength of the Evidence" field. The reasons or criteria used for downgrading were specified in the footnotes of the GRADE tables.

On the other hand, observational interventional studies started at Low, and so a score of -1 would be enough to take the grade to the lowest level of Very low. Observational studies could, however, be upgraded if there was: a large magnitude of effect, a dose-response gradient and if all plausible confounding would reduce a demonstrated effect.

See Sections 4.3.5.2 to 4.3.5.4 and Tables 5 to 7 in the full version of the guideline for additional details on grading of quality of evidence for prognostic and diagnostic studies and for qualitative reviews.

### Assessing Clinical Importance

The GDG assessed the evidence by outcome in order to determine if there was, or potentially was, a clinically important benefit, a clinically important harm or no clinically important difference between interventions. To facilitate this, binary outcomes were converted into absolute risk differences (ARDs) using GRADEpro software: the median control group risk across studies was used to calculate the ARD and its 95% confidence interval (CI) from the pooled risk ratio.

The assessment of clinical benefit, harm, or no benefit or harm was based on the point estimate of absolute effect for intervention studies which was standardised across the reviews. The GDG considered for most of the outcomes in the intervention reviews that if at least 100 participants per 1000 (10%) achieved (if positive) the outcome of interest in the intervention group compared with the comparison group then this intervention would be considered beneficial. The same point estimate but in the opposite direction would apply if the outcome was negative. For the critical outcomes of mortality, any reduction represented a clinical benefit. For adverse events, 50 events or more represented clinical harm. For continuous outcomes, if the mean difference was greater than the minimally important difference then this presented a clinical benefit or harm. For outcomes such as mortality any reduction or increase was considered to be clinically important.

This assessment was carried out by the GDG for each critical outcome, and an evidence summary table was produced to compile the GDG's assessments of clinical importance per outcome, alongside the evidence quality and the uncertainty in the effect estimate (imprecision).

### Clinical Evidence Statements

Clinical evidence statements are summary statements that are presented after the GRADE profiles, summarising the key features of the clinical effectiveness evidence presented. The wording of the evidence statements reflects the certainty/uncertainty in the estimate of effect. The evidence statements were presented by outcome and encompassed the following key features of the evidence:

- The number of studies and the number of participants for a particular outcome
- An indication of the direction of clinical importance (if one treatment is beneficial or harmful compared to the other or whether there is no difference between the two tested treatments)
- A description of the overall quality of evidence (GRADE overall quality)

### Evidence of Cost-effectiveness

Evidence on cost-effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:



- Undertook a systematic review of the economic literature
- Undertook new cost-effectiveness analysis in priority areas

## Literature Review

### The health economist:

- Critically appraised relevant studies using the economic evaluations checklist as specified in The Guidelines Manual
- Studies considered eligible but were excluded can be found in Appendix K

### Undertaking New Health Economic Analysis

As well as reviewing the published economic literature for each review question, new economic analysis was attempted by the health economist in priority areas. This was later downgraded to a costing analysis. Priority areas for new health economic analysis were agreed by the GDG after formation of the review questions and consideration of the available health economic evidence. Additional data for the analysis was explored through the use of audit data and discussion with the GDG. Model structure, inputs and assumptions were explained to and agreed by the GDG members during meetings, and they commented on subsequent revisions.

See Appendix L for details of the health economic analysis/analyses undertaken for the guideline.

### Cost-effectiveness Criteria

NICE's report 'Social value judgements: principles for the development of NICE guidance' sets out the principles that GDGs should consider when judging whether an intervention offers good value for money.

In general, an intervention was considered to be cost effective if either of the following criteria applied (given that the estimate was considered plausible):

- a. The intervention dominated other relevant strategies (that is, it was both less costly in terms of resource use and more clinically effective compared with all the other relevant alternative strategies), or
- b. The intervention cost less than £20,000 per quality-adjusted life-year (QALY) gained compared with the next best strategy

If the GDG recommended an intervention that was estimated to cost more than £20,000 per QALY gained, or did not recommend one that was estimated to cost less than £20,000 per QALY gained, the reasons for this decision are discussed explicitly in the 'from evidence to recommendations' section of the relevant chapter with reference to issues regarding the plausibility of the estimate or to the factors set out in the 'Social value judgements: principles for the development of NICE guidance'.

### In the Absence of Economic Evidence

When no relevant published studies were found, and a new analysis was not prioritised, the GDG made a qualitative judgement about cost effectiveness by considering expected differences in resource use between options and relevant UK National Health Service (NHS) unit costs, alongside the results of the clinical review of effectiveness evidence.

The UK NHS costs reported in the guideline are those that were presented to the GDG and were correct at the time recommendations were drafted. They may have changed subsequently before the time of publication.

## Methods Used to Formulate the Recommendations

### Expert Consensus

## Description of Methods Used to Formulate the Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

### Who Developed the Trauma Guidelines?

The four clinical guidelines and service delivery guidance consist of related topics with overlap in populations and key clinical areas for review. The



guidelines have been developed together to avoid overlap and ensure consistency. This required careful planning to ensure the Guideline Development Groups (GDGs) had the support they needed. Senior clinical expertise was recruited in addition to the standard GDG.

#### Project Executive Team

The overlap in the content of the four clinical guidelines and the service delivery guidance required an approach that ensured coherence and avoided duplication across the guidelines. To address this, clinical experts from across the guidelines were recruited to form an umbrella group, the Project Executive Team (PET). The PET met quarterly throughout the development of the guidelines. At the PET meetings, the members provided expert advice to the technical team and GDGs on the crossover of reviews across guidelines.

#### Guideline Development Group Expert Members

Expert members were healthcare professionals who worked across the four clinical guidelines and the service delivery guidance, and attended the GDGs that were relevant to their expertise. The expert members provided an additional level of coherence across the guidelines, helping to identify potential duplication in the areas of their expertise.

#### Guideline Development Group (GDG)

Each guideline 'stands alone' and addresses a specific area of care. A dedicated, multidisciplinary GDG, comprising health professionals, researchers and lay members developed this guidance.

The GDG was convened by the NCGC in accordance with guidance from NICE. The GDG met for two days every 6 weeks during the development of the guideline.

Staff from the NCGC provided methodological support and guidance for the development process. The technical team working on the guideline included a project manager, systematic reviewers, health economists and information scientists. The team undertook systematic searches of the literature, appraised the evidence, conducted meta-analysis and cost-effectiveness analysis where appropriate, and drafted the guideline in collaboration with the GDG.

#### Developing Recommendations

Over the course of the guideline development process, the GDG was presented with:

- Evidence tables of the clinical and economic evidence reviewed from the literature. All evidence tables are in Appendix G.
- Summary of clinical and economic evidence and quality as presented in Chapters 6-10 of the full version of the guideline
- Forest plots and summary receiver-operating characteristic (ROC) curves (see Appendix I)
- A description of the methods and results of the cost-effectiveness analysis undertaken for the guideline (see Appendix L)

Recommendations were drafted on the basis of the GDG interpretation of the available evidence, taking into account the balance of benefits, harms and costs. When clinical and economic evidence was of poor quality, conflicting or absent, the GDG drafted recommendations based on their expert opinion. The considerations for making consensus-based recommendations include the balance between potential harms and benefits, economic or implications compared with the benefits, current practices, recommendations made in other relevant guidelines, patient preferences and equality issues. The consensus recommendations were done through discussions in the GDG. The GDG also considered whether the uncertainty was sufficient to justify delaying making a recommendation to await further research, taking into account the potential harm of failing to make a clear recommendation.

The main considerations specific to each recommendation are outlined in the Evidence to Recommendation Section preceding the recommendation section in the full version of the guideline.

## Rating Scheme for the Strength of the Recommendations

#### Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Committee makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Committee is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

#### Interventions That Must (or Must Not) Be Used

The Guideline Committee usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the Guideline Committee uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

#### Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The Guideline Committee uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The Guideline Committee uses similar forms of words (for example, 'Do not offer...') when confident that an intervention will not be of benefit for most patients.

#### Interventions That Could Be Used

The Guideline Committee uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

## Cost Analysis

Economic evidence is provided for each review question in the full version of the guideline (see the "Availability of Companion Documents" field).

See also the "Availability of Companion Documents" field for the following:

- Appendix L: Cost Analysis for Open Fractures (overview and conclusions provided below)
- Appendix O: Additional Cost Data

#### Overview of Cost Analysis for Open Fractures

The aim of this analysis is to inform the Guideline Development Group (GDG) of the cost implications for the open fracture questions that relate to the timing of the initial debridement, the provision of plastic surgery services for the initial debridement and the increase in the number of surgery lists made available for definitive soft tissue cover. Three separate analyses are presented in sections L.2 to L.4 of Appendix L.

This analysis is intended to focus on issues of additional plastic surgery services and therefore does not specifically look at the costs of fixation. However, a costing comparing different numbers of theatre sessions is included in section L.4 to demonstrate the cost of performing procedures in either one or more stages. This captures the staff cost implications when fixation and/or soft tissue cover is staged, but the cost of metal implants and fixation devices is not included in this analysis.

#### Conclusion

From analysis 1: Debridement performed within 6 hours of injury with a plastic surgeon present in theatre is the most likely cost-effective strategy and may even be cost saving.

From analysis 2: One theatre list per week is not enough to meet the demand based on the incidence of open fractures and so two lists a week is generally regarded as current practice in the UK. The increase in costs per person for three surgery lists compared to two only requires a small improvement in health related quality of life, which is potential feasible. A further list would add the same overall cost but there may not be as much benefit to be gained and so the cost effectiveness of this is less certain. A list every day would add a much greater cost and so the uncertainty in cost effectiveness of this based on the clinical evidence available is much more uncertain. The incidence of open fractures is low and is an important consideration with regards to the cost effectiveness. However there may be other population that would benefit from additional theatre lists.

From analysis 3: If a plastic surgeon is to be present at debridement as the first analysis suggests is cost saving, performing all procedures in one session can save further costs. However, this may not always be possible due to the restrictions of the conclusions to the other analyses.

The analyses are inter-related as they reflect different parts of the same pathway. It may be possible that a costly change in strategy in one part of the pathway could be offset by savings made via a change in strategy in another part of the pathway. For the overall conclusions of these analyses and the discussion given by the GDG, please see the link to evidence section for treatment of open fractures (please see section 6.9.6 of the full version of the guideline).

## Method of Guideline Validation

## Description of Method of Guideline Validation

### Validation Process

The guidance is subject to an eight week public consultation and feedback as part of the quality assurance and peer review the document. All comments received from registered stakeholders are responded to in turn and posted on the National Institute for Health and Care Excellence (NICE) Web site when the pre-publication check of the full guideline occurs.

## Evidence Supporting the Recommendations

### Type of Evidence Supporting the Recommendations

Refer to the "Type of Studies" section in the "Description of Methods Used to Collect/Select the Evidence" field for a description of the studies that support the recommendations.

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Reduction in deaths and long-term health problems by improving the quality of emergency and urgent care in patients with complex fractures

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for benefits of specific interventions.

### Potential Harms

- The Guideline Development Group (GDG) felt that for long bone or hindfoot and midfoot open fractures the most important feature of the optimal destination was that it should provide orthopaedic care, which would usually mean it would be a major trauma centre (MTC) or a specialist centre for orthopaedic care. The benefits of getting the patient to orthopaedic care where the expertise exists to treat these patients in the timely manner required were believed to outweigh possible harms in terms of greater time in reaching that destination and the delay to starting treatment.
- The GDG acknowledged concerns about dealing with serious adverse effects when the antibiotics were given pre-hospital, but concluded that these would be outweighed by the potential benefits.
- It is not standard practice all over the country for paramedics to carry antibiotics, and there is a possibility of it inducing delays on scene. Paramedics also may not have knowledge on full patient history, such as allergies, which means there is an element of risk in administering antibiotics pre-hospital. This implies there is a trade-off between the risk of infection if antibiotics are delayed, and the risk of having severe adverse events, such as allergic reaction, outside of a hospital where treatment cannot be provided immediately. Severe infection could lead to amputation and further resource use, such as increased length of stay.
- The potential risk in transferring a patient who is severely haemodynamically unstable is that they may die during transfer.
- Whilst pelvic binders are extremely useful they do have potential harms, such as local ischaemia and skin breakdown. The GDG felt that whilst an overly short duration of binder use might lead to re-bleeding, any haemostatic benefit from binders diminishes after 24 hours. Furthermore, it was discussed that with greater binder duration adverse effects such as pressure sores (particularly in the context of de-gloving injuries) and contamination leading to infection become more likely. For example, some members of the GDG reported that after 7 days of binder use pressure necrosis is commonly seen in clinical practice.
- There is a potential risk of inducing haemodynamic instability from log rolling, as movement of an unstable pelvis may lead to further bleeding.
- Possible disadvantages of computed tomography (CT) scanning include increased radiation exposure, which may be particularly important

in children and young people.

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for additional detail on harms of specific interventions.

## Qualifying Statements

### Qualifying Statements

- The recommendations in this guideline represent the view of the National Institute for Health and Care Excellence (NICE), arrived at after careful consideration of the evidence available. When exercising their judgement, professionals are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or service users. The application of the recommendations in this guideline is not mandatory and the guideline does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or their carer or guardian.
- Local commissioners and/or providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

### Implementation Tools

Clinical Algorithm

Foreign Language Translations

Mobile Device Resources

Patient Resources

Resources

Slide Presentation

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

## Institute of Medicine (IOM) National Healthcare Quality Report Categories

### IOM Care Need

Getting Better

## IOM Domain

Effectiveness

Patient-centeredness

Timeliness

## Identifying Information and Availability

### Bibliographic Source(s)

National Clinical Guideline Centre. Fractures (complex): assessment and management. London (UK): National Institute for Health and Care Excellence (NICE); 2016 Feb 17. 18 p. (NICE guideline; no. 37).

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

2016 Feb 17

### Guideline Developer(s)

National Guideline Centre - National Government Agency [Non-U.S.]

### Source(s) of Funding

The National Clinical Guideline Centre (NCGC) was commissioned by the National Institute for Health and Care Excellence (NICE) to undertake the work on this guideline.

### Guideline Committee

Guideline Development Group (GDG)

### Composition of Group That Authored the Guideline

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## Financial Disclosures/Conflicts of Interest

At the start of the guideline development process all Guideline Development Group (GDG) members declared interests including consultancies, fee-paid work, share-holdings, fellowships and support from the healthcare industry. At all subsequent GDG meetings, members declared new and arising conflicts of interest.

Members were either required to withdraw completely, or for part of the discussion, if their declared interest made it appropriate. The details of declared interests and the actions taken are shown in Appendix B in the full guideline appendices (see the "Availability of Companion Documents" field).

## Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

## Guideline Availability

Available from the [National Institute for Health and Care Excellence \(NICE\) Web site](#) . Also available for download in ePub or eBook formats from the [NICE Web site](#) .

## Availability of Companion Documents

The following are available:

- Fractures (complex): assessment and management. Full guideline. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 278 p. (NICE guideline; no. 37). Available from the [National Institute for Health and Care Excellence \(NICE\) Web site](#) .
- Fractures (complex): assessment and management. Appendices. London (UK): National Institute for Health and Care Excellence; 2016 Feb. (NICE guideline; no. 37). Available from [NICE Web site](#) .
- Fractures (complex): assessment and management. Costing report. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 13 p. Available from the [NICE Web site](#) .
- Fractures (complex): assessment and management. Baseline assessment tool. London (UK): National Institute for Health and Care Excellence; 2016 Feb. (NICE guideline; no. 37). Available from the [NICE Web site](#) .
- Fractures (complex): assessment and management. Slide set. London (UK): National Institute for Health and Care Excellence; 2016 Mar. 118 p. (NICE guideline; no. 37). Available from the [NICE Web site](#) .
- The guidelines manual 2012. London (UK): National Institute for Health and Care Excellence (NICE); 2012 Nov. Available from the [NICE Web site](#) .

## Patient Resources

The following is available:

- Fractures (complex): assessment and management. Information for the public. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 11 p. (NICE guideline; no. 37). Available from the [National Institute for Health and Care Excellence \(NICE\) Web site](#) . Also available for download in eBook and ePub formats from the [NICE Web site](#) . Also available in Welsh from the [NICE Web site](#) .

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and

answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

## NGC Status

This NGC summary was completed by ECRI Institute on May 31, 2016.

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